Space Weather Technical Forecast

Issued on Tuesday, 10 September 2024 at 01:09 Local

From 24 September, the way we distribute this forecast is changing and you will need to take action to continue receiving it. You should have received an email on 04 September explaining the steps required to do this. If you have already signed up to receive the forecast on our premium website, please disregard this message. If you haven't, or if you need help with the process, please contact moswoc@metoffice.gov.uk

This technical forecast provides a four-day assessment of space weather events. The probabilities stated below are for reaching or exceeding the given levels. For more information about space weather impacts please see the Met Office Space Weather Scales https://www.metoffice.gov.uk/weather/learn-about/space-weather/uk-scales

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Space Weather Forecast Headline: Ongoing S1. R1-R2 Likely. G1-G2 Likely Tuesday 10 into Wednesday 11 September.

Analysis of Space Weather Activity over past 24 hours

Solar Activity: Activity as measured by GOES16 and 18 has been Moderate, with several low-level M-class flares observed from a diverse range of sources (Ex-AR3808, AR3815 and AR3814). The peak of these was an impulsive M3.4 at 09/1708UTC from AR3814, a Dhi/Beta-Gamma.

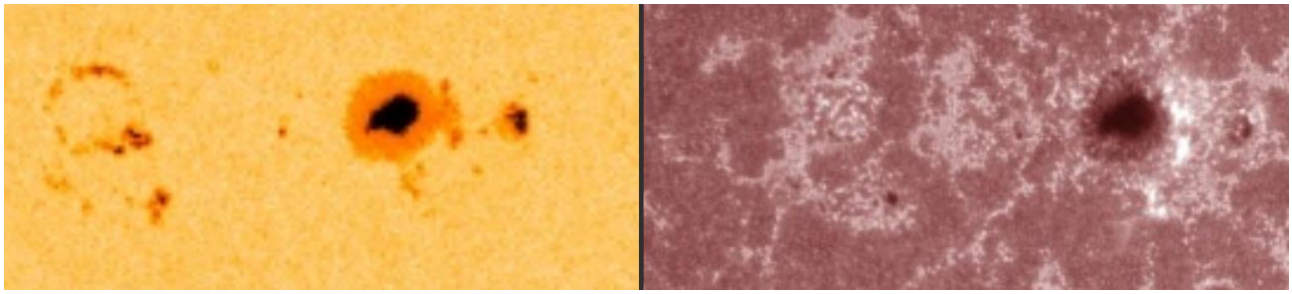

Figure 0: HMIIF and AIA1700 imagery of the 09/1708UTC M3.4 flare from AR3814 – the flare itself emanated from the minor sunspots immediately to the west of the main penumbral group. Also shown on the left of both images is the emerging unnumbered region that showed the most rapid growth of any on the disc in the period.

There are up to nine sunspot regions on the visible disc, although the partition of the southwest central cluster is somewhat subjective. The main changes in the period were the development of new leading spots in AR3814 in the northeast and AR3811 in the southwest. AR3816, also in the southwest, meanwhile showed development in its trailers and showed a spreading tendency.

The most-changed group of the 24-hours was the unnumbered region in the northeast, immediately east of the most active group AR3814, with the former undergoing significant growth in the 24 hours to become a Dri/Beta-Gamma.

No Earth-directed CMEs have been observed during the period, although imagery is being monitored for any CMEs arising from the central northeast M-class flares from AR3814. Coronagraph imagery showed an westward-heading CME from the long-period M1.0 from Ex-AR3808; a large eastward-heading CME from the oncoming sunspot cluster perhaps including Ex-AR3802; and finally a large far northeast-heading prominence eruption. None of these feature in the forecast.

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Solar Wind / Geomagnetic Activity: The solar wind measured by ACE at L1 showed an initial slow regime, followed by a possible stepped entry into a fast wind of unknown provenance. The phi angle has been mainly negative (towards the Sun), which precludes any contribution from CH65/+, which is otherwise favourably positioned.

The solar wind speed started the 24 hours at Background levels at 350km/s, rising slightly to 375 from 02UTC and further still to Slightly Elevated highs near 450km/s from 13UTC. The solar wind density was erratic but small-magnitude within typical single-figures ppcc throughout. The IMF rose to a Slightly Elevated peak of 13nT, while the north-south component varied between +12 and -8nT, with an overall co-aligned bias to help limit geomagnetic activity.

The net result of the above solar wind measures was for provisionally Quiet to Unsettled Kp indices, peaking with several intervals of Kp '3-'.

Energetic Particles / Solar Radiation: High energy (greater than 10 MeV) proton flux observed by GOES18 rose to exceed S1 for periods following 09/0845UTC, in the wake of the long-period M1.0 flare from Ex-AR3808. Flux levels peaked in the UTC evening at 33pfu. 50 and 100MeV protons showed no notable response.

High energy electron flux (greater than 2MeV) observed by GOES16 was at Normal Background levels. The associated 24-hour fluence remained below the Active threshold, with 1.29e6 integrated pfu observed at 09/2359UTC.

Four-Day Space Weather Forecast Summary

Solar Activity: Moderate activity is Likely to continue throughout, with a daily Slight Chance of X-class flares. The complexity and flare risk of oncoming sunspot regions is likely to exceed that from any departures through midweek UTC, and the overall risk is upwards around this time.

Solar Wind / Geomagnetic Activity: No significant fast winds feature in the forecast, and the main driver of geomagnetism in the period is therefore any glance from the 08 September filament CME. This is most likely due later in the UTC day of Tuesday 10 September into Wednesday 11 September with a Chance of G1-G2 Minor to Moderate geomagnetic storm, else being largely Quiet in the absence of any new events.

Energetic Particles / Solar Radiation: High energy proton flux should show a gradual exit from S1 levels through day one, Tuesday 10 September, eventually settling at a daily Slight Chance later in the current UTC working week.

High energy electron flux is expected to remain near current Normal Background levels throughout, with Active 24-hour fluence not expected.

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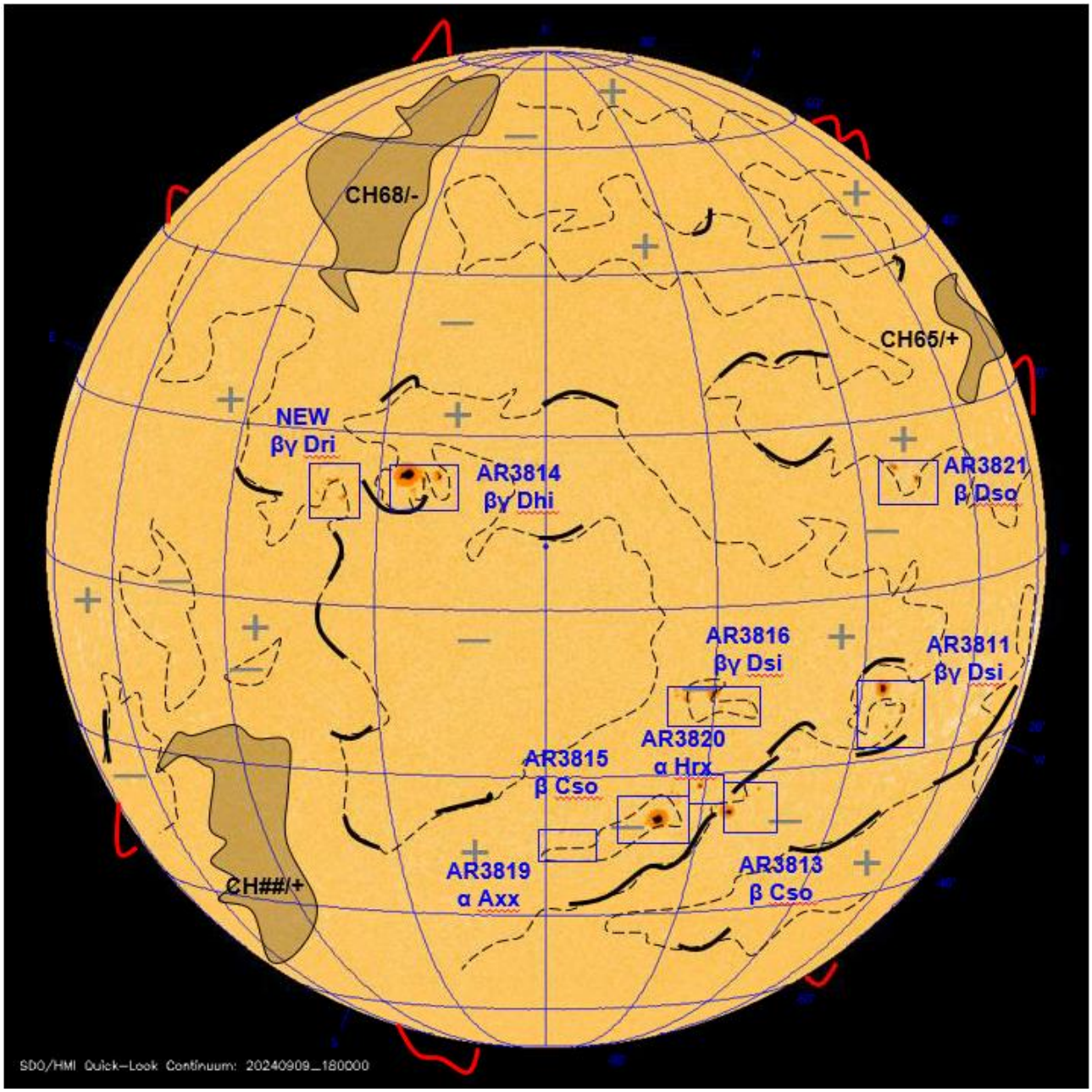
Figure 1. Solar Analysis Valid 09/1800UTC.



Key: Filament ___ , Prominence ___ , Magnetic Field Line - - - , Polarity +/-, Coronal Holes: Grey shaded area CHxx +/-, Sunspot groups 25xx - Mt Wilson α-β-βγ-βγδ and Zurich-McIntosh Axx etc.

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Geomagnetic Storms:

This four-day forecast period comprises minor fast wind influence to start, with one glancing CME due between Tuesday 10 and Wednesday 11 September.

The current minor fast wind does not have a clearly identified source on the disc (being of the wrong polarity to have originated from CH65/+), however has probably peaked at Unsettled geomagnetic intervals. This current fast wind is soon expected to fade. CH68/- is a high solar latitude persistent coronal hole, however this has retrogressed by around a day (13 degrees) on this rotation, which would very likely put any minor 450km/s fast wind into the coming UTC weekend rather than the end of the UTC working week (i.e. outside the forecast period). No significant coronal holes are therefore expected in the forecast.

The sole CME in the forecast arose from the filament eruption that occurred early on 08 September, and is likely to give Earth some glancing influence, either late on Day one, Tuesday 10 September, or early on Day 2 - Wednesday 11 September. This being said, the bulk of its ejecta is expected to pass ahead of Earth's orbit.

There is, on balance, considered a Chance of a period of G1-G2/Minor-Moderate Storm from the inbound CME, with no other significant contributions to the geomagnetic forecast from fast winds. Because the CME is a glancing blow this is represented in the probability tables as a relatively broad and flat peak risk, perhaps slightly more likely to peak on Wednesday 11 September in any ensuing magnetic cloud before waning into the later half of the week.

Geo-Magnetic Storm Probability (Exceedance)	Level	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC) (%)	Day 2 (00-24 UTC) (%)	Day 3 (00-24 UTC) (%)	Day 4 (00-24 UTC) (%)
Minor or Moderate	G1 to G2	No	30	40	10	1
Strong	G3	No	5	5	1	1
Severe	G4	No	1	1	1	1
Extreme	G5	No	1	1	1	1

Geomagnetic Activity - Earthbound Coronal Mass Ejections

Date/time 21.5R (UTC)	Halo: Full or Partial	Source	Source Location	Estimated Speed	Estimated Arrival Time	Comments
08/0525	Partial	Filament	NW	700km/s	11/0000UTC +/-12h	Glancing blow likely.

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Figure 2: Latest MOSWOC Enlil run and ensemble (badge time 09/1800UTC), pasued around the 1AU crossing time of the 08 September filament CME. The enhancement is shown boxed in magenta.

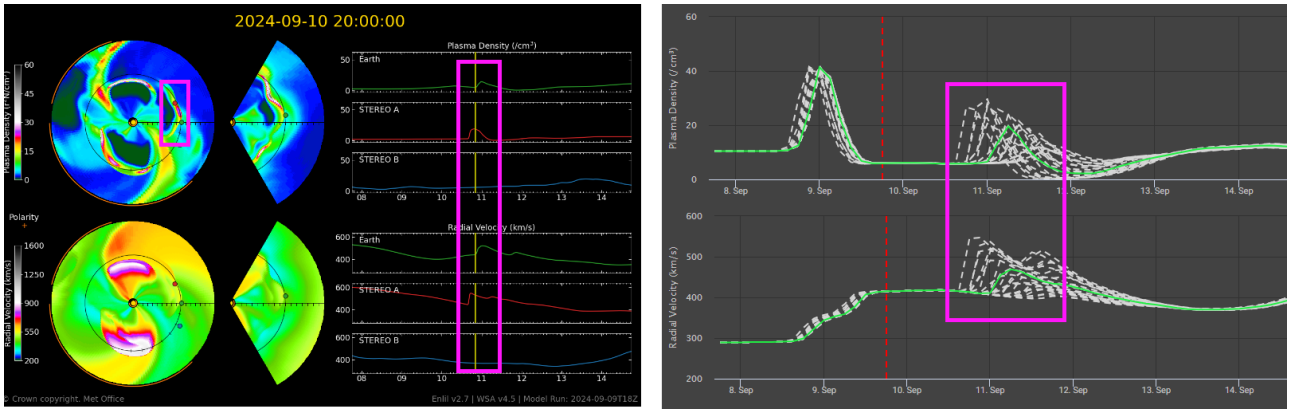
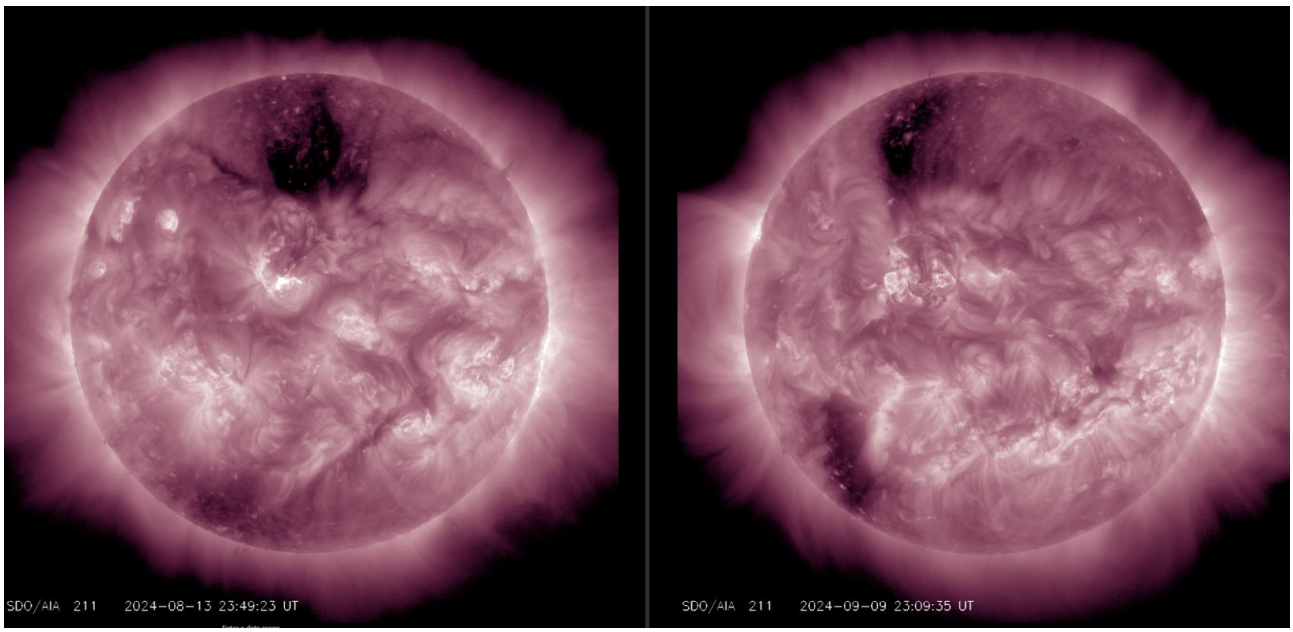


Figure 3: AIA211 imagery from 13 August and 09 September showing CH68/- and its predecessor lying near the meridian in the northern disc. Relative to last pass, this feature has retrogressed and therefore any influence will likely fall outside the four-day period.



Radio Blackouts - X-Ray Flares:

Activity in the past 24 hours has been well-spread between the off-going Ex-AR3808, the south-central AR3815 and the northeastern AR3814. None of the current front-sided regions particularly stands out in terms of complexity, however the most significant area of development lies immediately east of AR3814 and a new sunspot region denoted as a Zurich Dri in the latest analysis.

The imminently arriving eastern solar horizon encompasses several large returning regions including Ex-AR3790, 92, 93 and 3802, i.e. those roughly between Carrington Longitudes 025 and 040. One of the northern hemisphere regions, perhaps 3802 was responsible for a large and energetic CME in the past 24 hours off the eastern limb, and was perhaps also responsible for noteworthy far-sided CMEs on 03 and 05 September. As well as this northern hemisphere feature, there appears to be a magnetic connection to the southern hemisphere cluster (in e.g.

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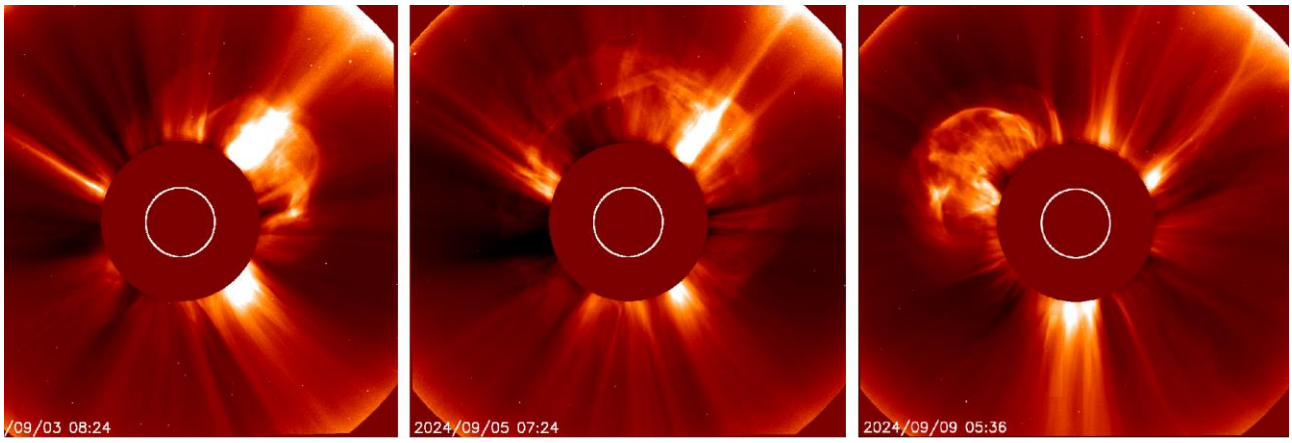
AIA171 imagery), and this part of the Sun returning to the facing side of the disc is therefore very likely to result in an upturn in daily flare risk.

With Ex-AR3806 rotating off the disc, there are no more departures expected until AR3811 and AR3821 follow suit by day four, Friday 13 September. Given the likely complex arrivals due by midweek UTC, the overall risk of significant flares is upwards in the period, with M class Likely and a Slight Chance of X-class.

X Ray Flares Probability	Level	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC) (%)	Day 2 (00-24 UTC) (%)	Day 3 (00-24 UTC) (%)	Day 4 (00-24 UTC) (%)
Active	**R1-R2 M Class**	Yes	60	70	70	70
Very Active	**R3 to R5 X Class**	No	10	15	15	15

Figure 4: Noteworthy trio of large far-sided CMEs in the past week, perhaps tied to Ex-AR3802 and due over the eastern limb around midweek UTC. This is part of the rationale for the uptick in X-ray flare probabilities around this time.



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Solar Radiation Storms - (High Energy Protons):

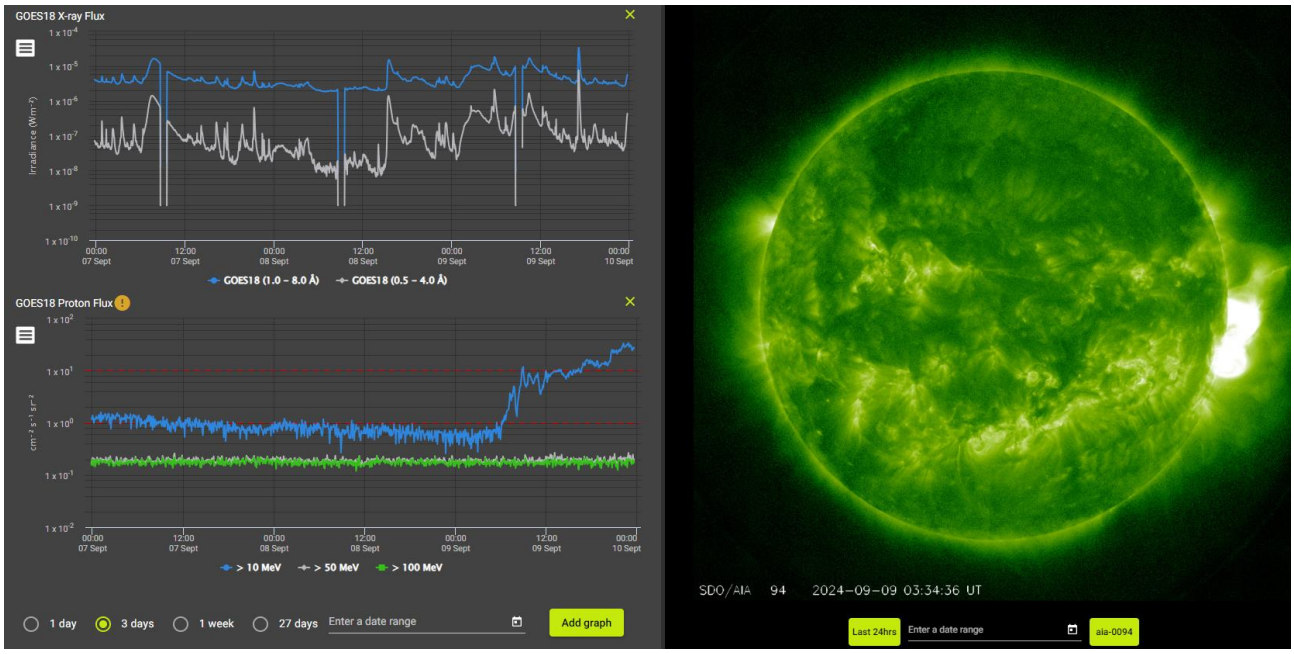
High energy proton flux showed a response to the long-period 09/0333UTC M1.0 from Ex-AR3808, which currently lies around 095W. The current enhancement is likely to gradually tail off during the first 24 hours of the forecast, eventually falling to a residual Slight Chance of further S1 events should Ex-AR3808 flare appropriately while still near the western limb.

Although probably sub-S1 by midweek UTC, proton flux at GEO will probably still be slightly elevated. This is likely to mean that any further slight enhancements will more readily exceed S1 for a time, although the baseline risk of a daily 20% Slight Chance of S1+ should have re-established into the second half of the working week. This takes into account the current crop of Earth-facing sunspot regions and also the decreasing contribution from Ex-AR3808.

It is still considered some days yet before any of the arriving far eastern limb sunspot regions play a significant role in the daily S-scale risks.

Radiation Storms	**Level (cm^{-2} sr^{-1} s^{-1})**	**Past 24 Hours (Yes/No)**	**Day 1 (00-24 UTC)**	**Day 2 (00-24 UTC)**	**Day 3 (00-24 UTC)**	**Day 4 (00-24 UTC)**
Probability (Exceedance)			**(%)**	**(%)**	**(%)**	**(%)**
Active	**≥ S1**	Yes	99	30	20	20
Very Active	**≥ S3 ***	No	1	1	1	1
* S3 ≥ 10 MeV ≥ 1000 pfu and / or ≥ 50 MeV ≥ 10 pfu. (pfu = $cm^{-2}sr^{-1}s^{-1}$)						

Figure 4: GOES18 X-ray flux and high energy protons over the past 72 hours, showing a response to S1 in the wake of the 09/0333UTC M1.0 flare from Ex-AR3808 (shown at peak in AIA094, right).



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High Energy Electrons Event (≥ 2MeV):

The diurnal oscillation of high energy electron flux has been within the confines of Normal Background levels in the past 24 hours. While Earth may now have connected with a minor fast wind, the fact that this appears to have now peaked should mean there is little likelihood of Active 24-hour fluence resulting, especially since the 08 September CME is perhaps due at a time when any recovery of the Van Allen belts to encompass GEO might be expected.
All considered, the chances of Active 24-hour fluence are very low throughout.

GEO Electron Environment	Level (cm^{-2} sr^{-1} day^{-1})	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC)	Day 2 (00-24 UTC)	Day 3 (00-24 UTC)	Day 4 (00-24 UTC)
Probability (Exceedance)			(%)	(%)	(%)	(%)
Active	≥ 2 MeV ≥ $1x10^{8}$	No	1	1	1	1
Very Active	≥ 2 MeV ≥ $1x10^{9}$	No	1	1	1	1

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